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REPORT
ON
PRESPLITTING ROCK BACKSLOPES

HIGHWAY COMMISSION

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January 25, 1967

Montana State Highway Department
Sixth & Roberts Street
Helena, Montana 59601

ATTENTION: Mr. Jack R. Beckert
Pre-Construction Engineer

Re: Presplitting Rock Backslopes
Clinton-Beavertail
I-90-2 (24) 120
I-90-2 (24) 128
I-90-3 (4) 132

Gentlemen:

Enclosed are the recommendations concerning presplitting the rock cuts on the above mentioned projects, which you requested in a letter dated August 12, 1966.

We have included a general discussion of presplitting, specific recommendations for each rock cut on the Clinton-Beavertail project, a recommended presplitting specification and a scaling specification.

While the scaling was not requested in the original authorization, we felt that due to the nature of a presplit backslope the scaling required would be a relatively small but necessary item, as a presplit face is usually very smooth and any material falling down the slope would probably accelerate faster than on a non-presplit face. Consideration of including the scaling Special Provision in all projects containing rock excavation should be made as a scaled backslope will give a more desirable appearance, reduce the rockfall hazard, and reduce future maintenance.

The report and specifications have been prepared through an assimilation of data, by field observations in Wolf Creek Canyon, discussions with construction men and suppliers representatives and reviewing various existing State and Federal specifications. The Bureau of Public Roads is expected to publish a comprehensive report on presplitting in the near future which is to be distributed to all State Highway Departments. This report should be valuable in aiding field and office judgement of the presplitting operation.

Since the enclosed suggested specifications have not yet been reviewed by the Highway Department they have not been included in our proposed special provisions for the projects. We assume you will include them if they are approved.

Upon your review of the following report we would be available for a meeting to discuss these proposed recommendations, should you so desire.

Very truly yours,

MORRISON-MAIERLE, INC.

William D. Thornby, P.E.

Encl:
WDT/jf

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PRESPLITTING ROCK BACKSLOPES
Prepared By
MORRISON-MAIERLE, INC.
For
MONTANA STATE HIGHWAY COMMISSION

General Discussion

Presplitting or preshearing, as it is sometimes called, is the construction operation of drilling a single row of holes along the backslope of a rock cut, loading them with a light explosive charge and firing them prior to the primary blasting of the cut to establish a shear plane along the backslope.

This is a relatively recent development in blasting procedure with very little use in Montana, however, it has been recognized and used extensively in other states with apparently great success.

The advantages of "Presplitting" rock backslopes are mainly divided into two areas.

The first advantages are the appearance and maintenance features. These benefits are realized because presplitting gives a relatively smooth backslope free from large outcrops, and also protects the backslope from the effects of the primary blasting, due to the established shear plane. This protection reduces initial overbreak and future rock fall problems caused by disturbed or new fracture planes. See pages 8 and 10.

The second advantage would be the possible economy of presplitting, both to the contractor and to the Montana State Highway Department. In respect to the contractor this economy is a very intangible item due to the variance of blasting procedures, percentage of overbreak, reduction of scaling and other construction operations. Due to its nature it would take

considerable time and experience of actual project cost accounting to be able to accurately define the monetary advantages or disadvantages realized from presplitting. A contractor is also given additional incentive to presplit if the specifications do not allow payment for overbreak. One indication of the economy aspect is that on the Hardy Creek South Interstate project the contractor has elected to presplit without being required to by the specifications. However, this is the only instance of unspecified presplitting in the State of which we are aware and other contractors have not as yet elected to take this option.

The economy consideration with respect to the Montana State Highway Department would be the additional cost of presplitting being balanced by the initial savings of reducing or eliminating overbreak, and the long range saving of reducing rockfall maintenance. Another savings that has been realized by presplitting is the steepening of backslopes due to the stronger remaining face. However, it would not appear feasible to steepen the slopes where bedding failure is a problem as indicated at Clinton-Beavertail.

There are no apparent disadvantages other than the direct or indirect added cost in specifying presplitting in all rock cuts but there are conditions and formations not benefited by this technique or where the presplitting effect is minimized.

This is true where weak bedding planes are evident in a rock structure and the backslope is parallel to the dip. Here the rock will generally break along these planes without presplitting giving a smooth backslope.

If the weak bedding planes are close enough together primary blasting may not be required prior to excavation.

One problem in the construction methods of presplitting is that it takes considerable effort on the part of the drillers to obtain proper orientation and "Lining-Up" on the backslopes, particularly on flatter slopes. This orientation is of vital importance to obtain satisfactory results. See Page 9.

Most presplitting specifications reviewed for this study did not require presplitting on slopes of 1:1 or flatter. The following are the probable reasons for this: (1) As pointed out above the difficulty of holding the correct drilling alignment, (2) difficulty of loading and stemming the holes, (3) when a rock backslope is this flat it cannot be considered competent, (4) these slopes are flat enough so that the backslope strength gained from presplitting is not as necessary.

With regard to the measurement and payment of presplitting two methods are commonly used, the first is to make presplitting incidental to the cost of excavation. It has the advantage of relieving the Engineer of the measurement task and could avoid arguments with the Contractor regarding unexposed holes, abandoned holes not exposed after shooting, etc.. However, it has the inherent disadvantage of many newly specified construction operations of possibly being overlooked by the contractor during estimating and bidding from lack of study of the specifications. If this occurs with the successful bidder, difficulties may be encountered in obtaining the desired construction results on the whole project due to his effort to make

up for his cost omission. It would probably be a new construction operation to many contractors and until experience is gained by them the reflection of the cost in the unclassified excavation item could be quite variable. When the cost is absorbed in the excavation bid item it will be spread over many units and may tend to be obtained lower than when paid for as a separate bid item. The second method is to pay per lineal foot of drill hole. This provides control by the Engineer of the extent of drilling to be done. A definite construction cost savings would be possible by reduction of the bid item quantity if it is found not to be effective and doesn't produce the desired result in certain rock formations. This method would also provide the State with specific cost information for the work for future evaluation.

If the interval of presplitting can be determined and specified before the contract letting, the first method of measurement of payment may be preferred, but if this spacing cannot be determined prior to construction, then the second is probably more desirable. It must be recognized, however, that initiation of the presplitting procedure will probably result in additional construction cost no matter which method of measurement and payment is used.

The lineal foot method allows more freedom for the project engineer to pick the widest spacing that will effectively do the job, and the contractor then is paid for only what he does.

General Recommendations

From the above comments, it is concluded that presplitting should be recommended in all rock cuts that are drilled and shot to retain the maximum amount of backslope stability for the following reasons. The shear plane

developed will essentially insulate or considerably reduce the fracture in the remaining rock face which will provide a stronger more stable and maintenance free condition. Any reduction of overbreak will reduce the construction cost and also will reduce construction engineering problems, that is finding areas to place the excess material or "rebalancing" the project. Special consideration should be given to the specifying of presplitting slopes 1:1 or flatter, on an individual cut basis to determine whether it is necessary or desirable.

Until more experience and judgement is obtained in this field the second method of measurement and payment is recommended, that is payment on lineal foot of drill hole. The total cost per lineal foot of presplitting hole is estimated to range from $.90 to $2.00, depending upon field conditions.

It is also recommended to include the scaling special provision in the contract due to the appearance, hazard elimination, and maintenance benefits. Measurement and payment for scaling can also be considered incidental to the Unclassified Excavation bid item or on a unit basis. The former basis puts the burden of initiative on the contractor. The latter, if bid on a man-day unit, can be controlled in extent and payment would be made only for work authorized and done. If this latter basis is used an additional restrictive provision such as the following should be used: The actual extent of areas to be scaled will be designated by the Engineer and will not be started without the written authorization of the Engineer. It is recommended that the scaling be considered incidental to Unclassified Excavation on the Clinton-Beavertail projects.

Specific Recommendations

The following are the recommendations for presplitting on the Clinton E-W and Beavertail E-W projects on a cut by cut basis.

Station 279+15 to 308+00, Backslope 1:1 and 1.1:1

Presplitting is not recommended in this area due to the backslope being 1:1 or flatter, and the backslope being designed parallel to the bedding planes. There is a possibility that portions of this cut are rippable; this could depend on the contractors operations.

Station 308+00 to 323+00, Backslope ½:1

Recommended for presplitting (See General Recommendations).

Based on 3' centers, this cut would require 83,650 lineal feet of drill holes for presplitting for 498,000 CY of rock excavation.

Station 471+50 to 490+50, Backslope 1¼:1

Presplitting is not recommended on this cut due to the backslope being flatter than 1:1, and also there is a definite possibility this cut will be rippable, due to weak bedding planes.

Station 537+50 to 546+00, Backslope 1.2:1

Presplitting not recommended due to the backslope being flatter than 1:1 and the backslope being approximately parallel to the bedding. This cut will probably be excavated without blasting.

Station 560+00 to 567+00, Backslope 1.2:1

Presplitting not recommended due to the backslope being flatter than 1:1 and the backslope being approximately parallel to the bedding. This cut will probably be excavated without blasting.

Station 627+00 to 634+25, Backslope ½:1

Recommended for presplitting (See General Recommendations).

Based on 3' centers this cut would require 29,200 lineal feet of drill holes for presplitting for 251,000 CY of rock excavation.

Station 634+25 to 637+00, Backslope $1\frac{1}{2}$:1

Presplitting not recommended due to the backslope being flatter than 1:1.

Station 718+00 to 721+50, Backslope $1\frac{1}{4}$:1

Presplitting is not recommended due to the backslope being flatter than 1:1, and the probability this cut will be rippable because of weak bedding planes.

Station 734+00 to 748+00, Backslope $1\frac{1}{4}$:1

Presplitting is not recommended due to the backslope being flatter than 1:1 and the probability this cut will be rippable, because of weak bedding planes.

Station 778+30 to 786+50, Backslope $1\frac{1}{4}$:1

Presplitting is not recommended due to the backslope being flatter than 1:1 and the probability this cut will be rippable, due to weak bedding planes.

Station 786+50 to 795+00, Backslope 3/4:1

Recommended for presplitting (See General Recommendations).

Based on 3' centers this cut would require 10,400 lineal feet of drilling holes for presplitting for 135,000 CY of rock excavation.

The following 3 pages of photographs taken on the Hardy Creek South and Craig North projects illustrate some of the conditions discussed above and in the following specifications.

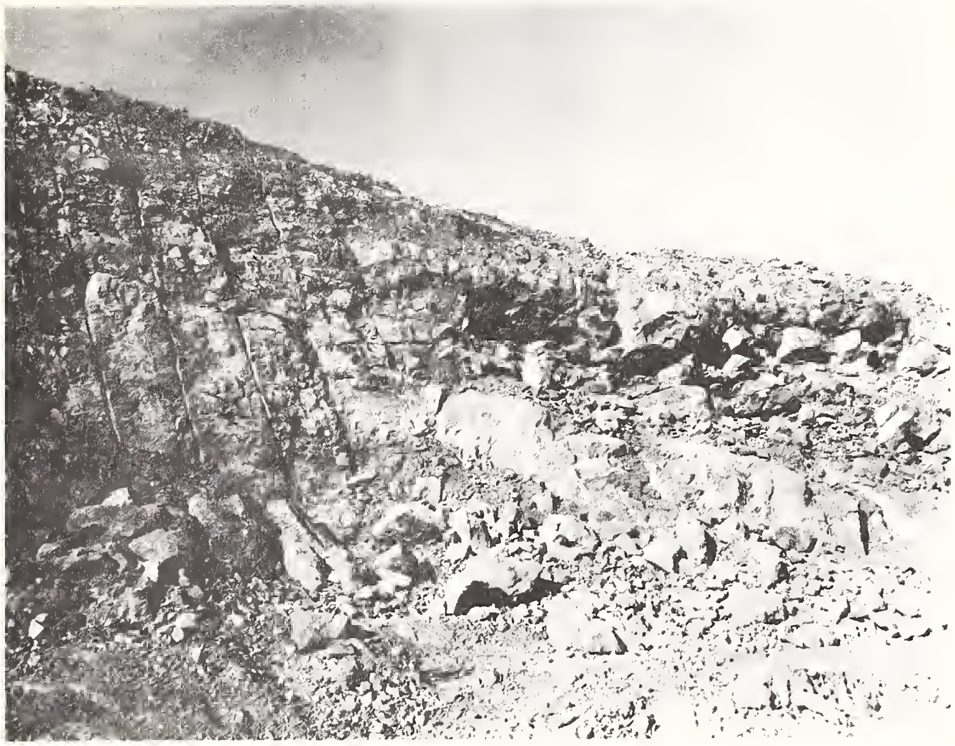

Figure 1. Left $\frac{1}{2}$ of picture presplit, right $\frac{1}{2}$ used conventional techniques.

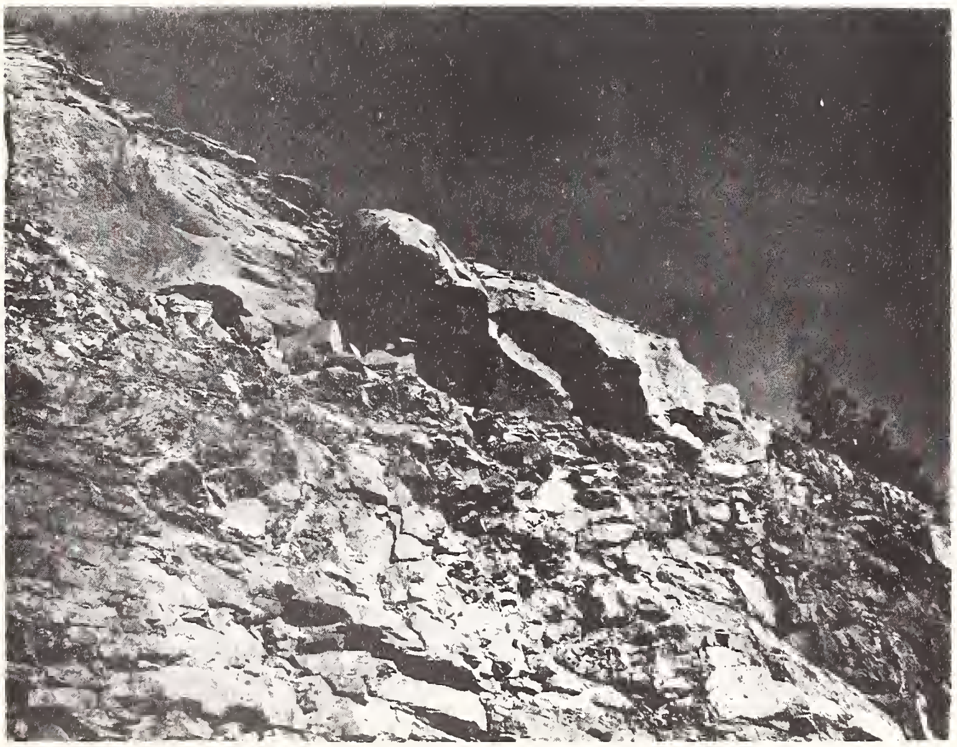

Figure 2. Presplitting would eliminate large outcrops as shown above. This outcrop juts out of the backslope approximately 5'.

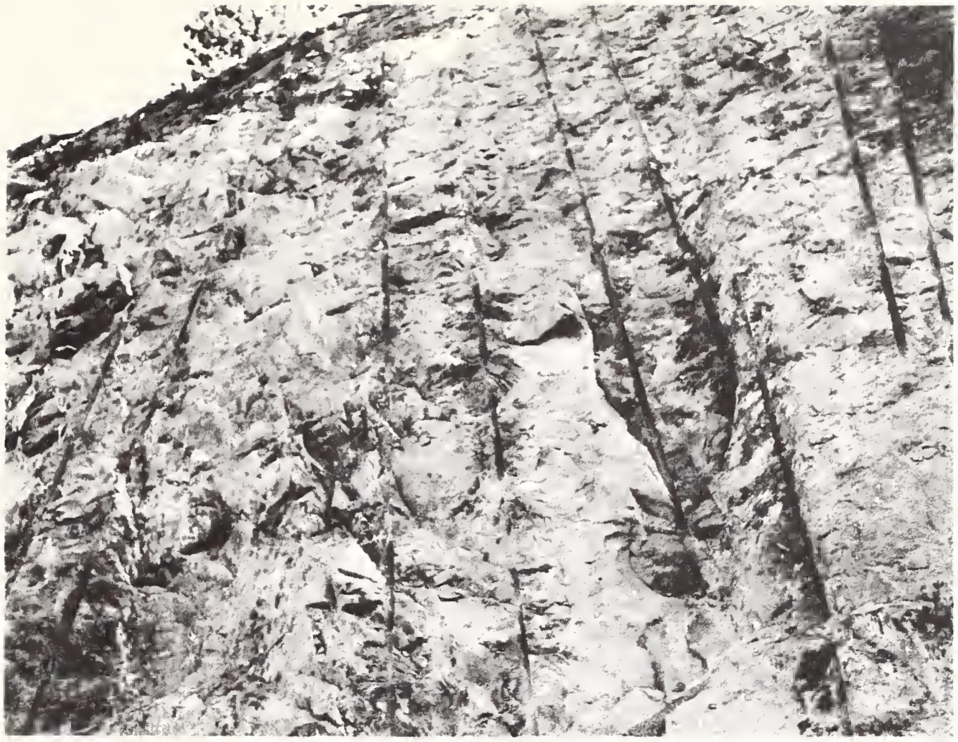

Figure 3

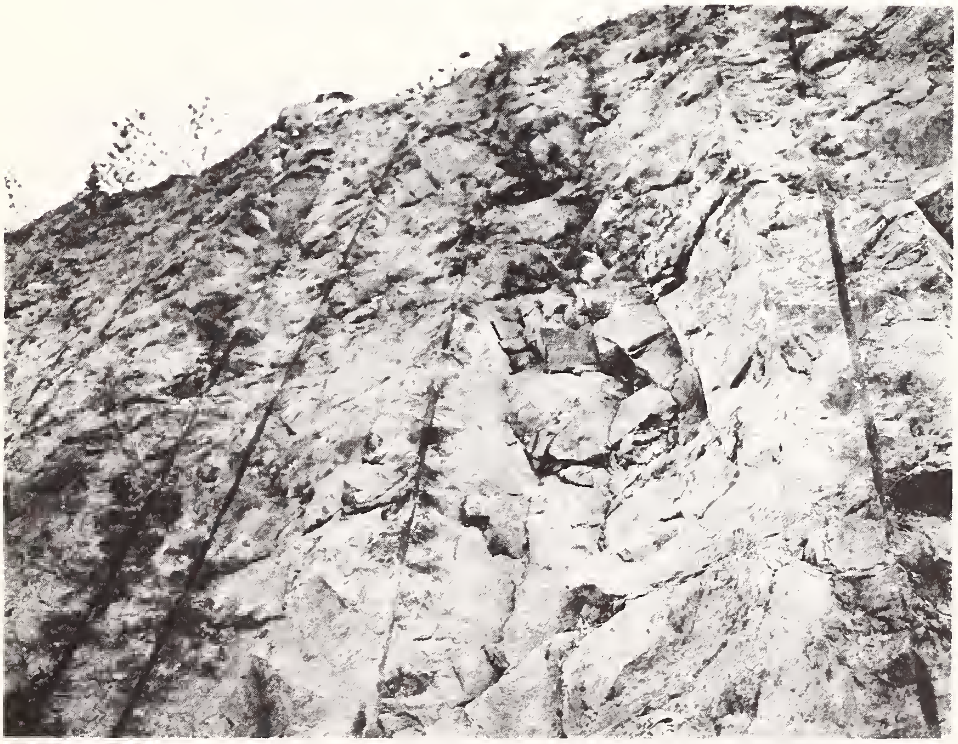

Figure 4. Figures 3 & 4 show what happens when drilling deviations in alignment and slope exist. See Figure 6 for proper results. The desired interval was 3.5' to 4'.

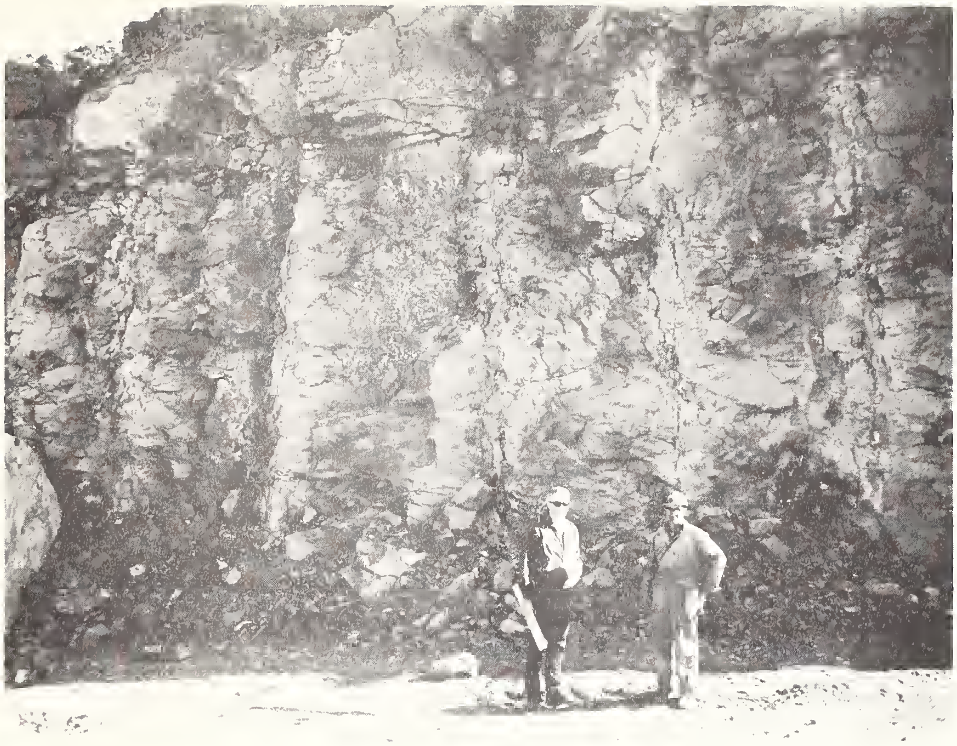

Figure 5. An excavated non-presplit slope approximately 50' in front of Figure 6, which shows a satisfactory presplit backslope.

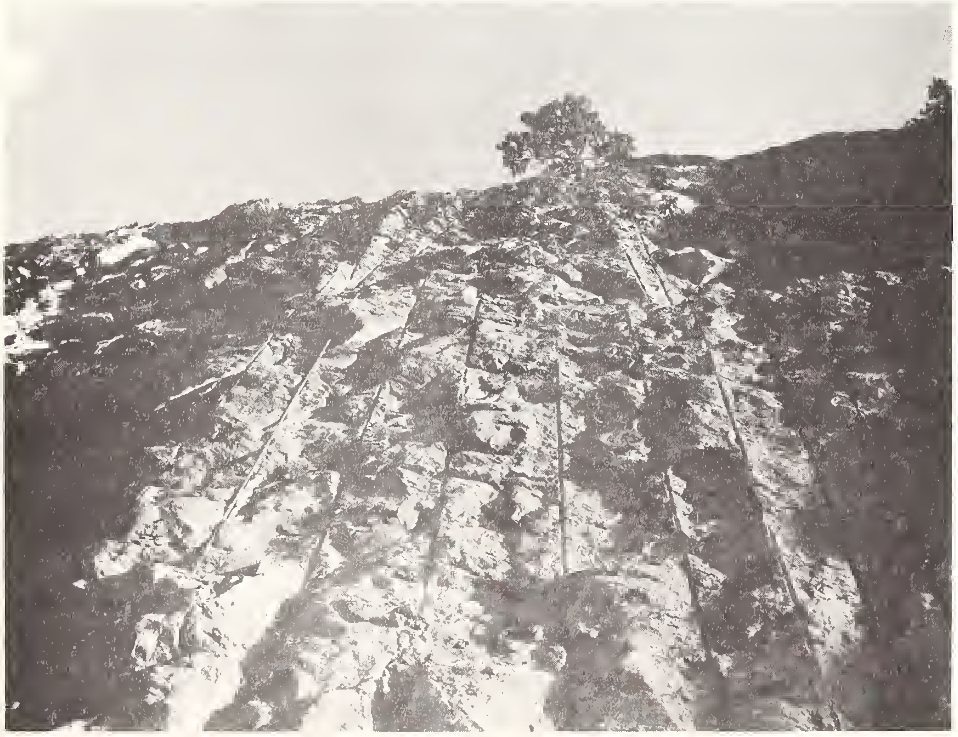

Figure 6

The following are the proposed Special Provisions for "Presplitting Rock Cuts" and "Scaling Rock Cuts." They have been prepared as a special provision applicable to any project with rock slopes.

SPECIAL PROVISION

FOR

PRESPLITTING ROCK BACKSLOPES

Description

All backslopes in rock cuts steeper than 1:1 that are to be excavated using blasting techniques shall be formed by presplitting. Presplitting is defined as the construction of a shear plane in rock by the controlled usage of explosives and blasting equipment in properly aligned and suitably spaced drill holes, causing a continuous or semi-continuous fracture between these drill holes.

The primary objectives for presplitting rock backslopes is to perform the work in such a manner that rock outside of the excavated prism will be undisturbed and the shape of the excavated prism will conform to lines and grades shown on the plans. It shall be the responsibility of the Contractor to conduct his operations in such a manner that the stated objectives are achieved, or as nearly achieved as possible.

Construction Methods

A. Drilling

The holes for presplitting shall be drilled along the designated slopes at intervals of approximately 1½' to 4'. An interval of 2.5' to 3' is a generally recommended trial spacing. The holes shall be from 2" to 4" in diameter and all holes in any cut shall have the same diameter unless otherwise approved by the engineer. The contractor shall vary the spacing and size of the holes to suit the material encountered. This interval and hole size

shall be approved in the field, for each cut or changed condition, by the engineer as necessary to produce a relatively smooth face tolerably free of loose rock.

The contractor shall exercise sufficient care to insure that the holes are in proper alignment and slope as the final results are directly dependent on the consistency of the interval spacing, alignment, and slope.

Drilling shall be limited to a depth of accurate drilling and the maximum depth shall be limited to 20' to 25' unless the contractor can demonstrate by actual drilling procedure that he can drill to greater depths with sufficient accuracy.

Drilling deviations greater than 6" from the neat lines will produce undesirable results.

If the depth of the rock cut is greater than the maximum permissible depth of the holes, the presplitting shall be accomplished in two or more lifts.

In this event a 1' offset will be allowed for the subsequent presplitting operations on the next lift, provided that a slope adjustment is made to bring the base of that lift back onto the proper backslope.

B. Blasting

The explosives used in presplitting shall be of such quantity and used in such manner so as not to open seams nor otherwise damage the rock remaining in the backslope.

The explosive shall be a 40 per cent extra strength dynamite or other approved explosives that will produce equally satisfactory results and the charges shall be prepared by taping fractional portions of standard

explosive cartridges to a length of detonating fuse equal to the depth of the drill hole.

Charges shall be uniformly spaced throughout the length of the hole with charges attached to detonating cord using an evenly distributed charge of one tenth to three quarters of a pound of dynamite per linear foot of depth. Loading of $\frac{1}{4}$ pound per foot is a generally recommended charge for presplitting. In addition one pound of dynamite shall be concentrated at the bottom of each hole.

In some materials overbreak will occur at the top of a slope, such as at a bench, with a standard load. If this occurs a reduction of 50% of the charge may be made in the upper portion of the hole.

The charges shall be spaced at intervals of approximately 24 inches center to center of charge. The size and spacing of the individual charges may be varied, as approved by the Engineer for each cut or changed condition. The charges in adjacent holes shall be staggered.

After a charge is prepared it shall be lowered into the hole and stemmed completely with clean stone chips or sand passing a 3/8-inch standard sieve unless the rock is free from faults, voids or other conditions which prohibit good results, then stemming will be required only in the top 3' of the hole. All presplitting charges in any blast shall be exploded simultaneously. The presplitting shall be shot in advance of the primary blasting operations. However, if satisfactory results can be obtained, both blasting operations may be shot in the same circuit provided the primary blasting is delayed until after the presplitting detonation.

If satisfactory results can be obtained and if approved by the engineer, every second drill hole need not be loaded with explosives and consequently will serve as guide or relief holes.

C. General.

All primary blasting holes shall be drilled at least 3 feet from the presplit face and farther, if necessary, to avoid overbreakage. These holes shall also be loaded in such a manner and quantity so as to avoid overbreakage.

It shall be the intent of this specification to obtain a presplit backslope that will not deviate more than 9 inches from the desired line of drill holes, except where the character of the rock being presplit (badly broken rock, seams, etc.) will unavoidably result in irregularities.

The Engineer shall approve the drill spacing, drilling depths, stemming requirements, explosive loadings or any other construction procedures covered in the specifications to obtain the above mentioned results. The engineer shall have the authority to delete presplitting in any portion of the project if the desired results are not obtainable or the effectiveness of presplitting is not realized.

Method of Measurement and Basis of Payment

Method 1 - The cost of presplitting will be considered incidental to the bid item Unclassified Excavation and no direct measurement or payment will be allowed for this operation.

Method 2 - Presplitting shall be measured by the lineal foot of presplitting holes drilled.

Presplitting shall be paid for at the contract unit bid price, which price and payment shall be full compensation for the work.

SPECIAL PROVISIONS

FOR

SCALING ROCK BACKSLOPES

Description

All loose or detached blocks of rock, masses of soil, and loose rocks that are or will be a hazard due to their position, shall be removed from the backslope that is steeper than 2:1 by barring, wedging, or any other necessary operations. In addition, during excavation of each lift, the rock face shall be raked, if necessary with a shovel bucket to remove loose slabs and shattered rock as directed by the Engineer. The scaling operation shall be performed in such a manner so as to minimize or eliminate the need for men to work at hazardous heights and conditions.

Measurement & Payment

The cost of scaling will be considered incidental to the bid item "Unclassified Excavation" and no direct measurement or payment will be allowed for this operation.